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DENTITION OF SOME DEVONIAN FISHES

DURING the last few years our knowledge of the multiplicity and relationships of the Middle and Upper Devonian fish-faunas in this country has been enlarged by the discovery of much new material. Exceptionally interesting finds have been made in the Marcellus, Hamilton, and Naples shales of New York, the Chemung-Catskill of Pennsylvania and its presumable equivalent in Johnson county, Iowa, in the Corniferous of Ohio, and in the Hamilton limestone of Wisconsin and adjoining states. From the last-named horizon notable collections have been brought together and rendered accessible for study by Messrs. E. E. Teller and C. E. Monroe and the late T. A. Greene of Milwaukee, and Professors Calvin and Udden of the Iowa State Geological Survey. These have been freely drawn upon in the preparation of the following notes.

GENUS *DINICHTHYS*, NEWBERRY

So intimately related are the two best-known Arthrodires, *Coccosteus* and *Dinichthys*, that the only crucial test of generic distinctness is afforded by the dentition. Likewise, for the discrimination of species, dental characters are all-important. Among the body-plates the chief distinctive characters are furnished by the dorso-median and clavicular.

1. *D. pustulosus* E. (Fig. 1). — Although remains of this Hamilton Dinichthyid are tolerably abundant, nothing was known of its dentition until recently, when one large premaxillary, nearly equaling that of *D. terrelli* in size, and two maxillary or shear-teeth were found by Mr. Teller in the hydraulic cement quarries of Milwaukee. Last fall a fragmentary mandible showing rudimentary denticles along the posterior slope of the cutting edge was obtained from the Hamilton of New Buffalo, Iowa, by Professor Udden, and still more recently Mr. Monroe

was fortunate enough to secure at the typical Milwaukee locality the specimen shown in Fig. 1.

The inner face of this specimen is attached to a block of limestone, a part of the anterior extremity is broken away, and a considerable portion of the posterior end is missing. The total length may be estimated at about 24^{cm}, the proportions being about the same as in *D. curtus*, and about three quarters the size of an adult individual of *D. intermedius*. The posterior end is more slender than in either of these species, and the cutting edge also differs in having no prominence back of the tooth-like beak. The cutting edge of *D. intermedius* has one such prominence, and that of *D. curtus* two. In *D. curtus* "the posterior end of the cutting edge is set with two or three unequal denticles in place of the series of even, lancet-like points in the same position on the mandible of *D. intermedius*."[1] But in the present form these denticles are reduced to mere swellings, of which five may be counted along the posterior slope of the cutting edge. Professor Udden's specimens, altho smaller, shows the bosses more prominently; they are, in fact, rudimentary denticles, and represent the initial stage of those structures which are such a conspicuous feature in *D. herzeri* of the Ohio Shale.

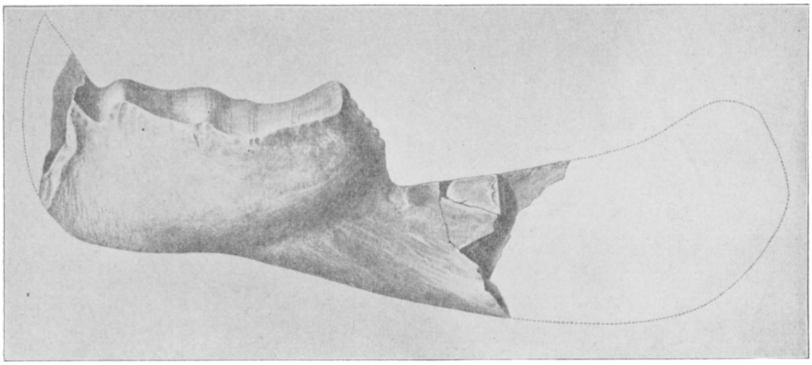

FIG. 1. *Dinichthys pustulosus* E. Hamilton; Milwaukee, Wisconsin. Left mandible. $\times \frac{2}{5}$.

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[1] NEWBERRY, J. S., Pal. Fishes N. A. (Mon. U. S. Geol. Surv., Vol. XVI, p. 156), 1889.

The cutting edge of the mandible is beveled to a sharp edge, and shows the usual indications of wear. It belonged to an average or slightly undersized individual, judging from the proportions of a dozen crania that have been found at Milwaukee. The largest of these, it should be noted, is only one fifth smaller than an averaged-sized head of *D. terrelli.* The premaxillaries and shear-teeth do not call for any special comment, except that the latter are without denticles on the posterior margin.

2. *D. halmodeus* (Clarke).—The presence in the type specimen of functional premaxillary teeth, and of a carinal process on the under side of the dorso-median, are sufficient reasons for transferring this species from *Coccosteus* to *Dinichthys.* The mandibles, which measure about 6.5^{cm} in length, have in place of a cutting edge a series of seven or more backwardly directed denticles. The anterior beak is missing in both mandibles, and the premaxillaries are also damaged. The latter are relatively very powerful, and provided with an elongated base for attachment to the visceral surface of the cranium. The plates designated as *x*, *mx*, *pmx*, and *pto*, in Dr. Clarke's diagram[1] are all parts of a single element, the suborbital. Examination shows that the cranial osteology and structure of the dorso-median are normal in every way.

3. *D. herzeri* Newb.—This species is commonly supposed to be limited to the Huron Shale, but it probably had a continuous range from base to summit of the Ohio Shale. Its occurrence in the Cleveland Shale may be strongly suspected, if indeed it is not proved by two specimens described by E. W. Claypole. The first is the fragmentary mandible known as *D. kepleri* Cl.,[2] and the second is the series of massive plates (plastron and clavicular) preserved in the Ohio State Museum, and figured in part in Vol. VII of the *Ohio Geological Survey Reports* (Pl. XXXVIII–XL). The clavicular and postero-ventro-median each have a length of about 50^{cm}, and the postero-ventro-laterals are over 76^{cm}

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[1] Thirteenth Ann. Rep. State Geol. N. Y., Vol. I, 1893, p. 162.

[2] Amer. Geol., Vol. XIX, 1897, p. 322, Pl. XX.

long, indicating a creature about two fifths larger than the average of *D. terrelli*. Believing these proportions too large for any known species of *Dinichthys*, Claypole[1] referred the remains to *Titanichthys;* and later the name of *D. ingens* was suggested for them by Wright.[2] We propose to cancel both this title and that of *D. kepleri* in favor of the type species of *Dinichthys*. Other plates of huge size belonging in all probability to the same species are preserved in the museum of Kentucky State University at Lexington.

4. *D. clarki* (Claypole).—A large species of *Dinichthys* allied to the preceding, so far as may be judged from the dentition, was made the type of a new genus by Claypole,[3] and named by him *Gorgonichthys clarki*. No characters are shown, however, which warrant a separation of this form from *Dinichthys;* on the contrary, the mandible displays an interesting stage of modification between denticulated forms like *D. herzeri*, *D. halmodeus*, etc., on the one hand, and those with a sharp cutting edge like *D. terrelli* on the other.

The type of the so-called "*Gorgonichthys*" and the large premaxillary described by Claypole[4] as *Dinichthys clarki* have, of course, nothing in common. The relations of the latter are not accurately determinable. If excluded from *Dinichthys*, a new generic name will be required; if retained, a new specific name is necessary.

GENUS *CLADODUS*, AGASSIZ

This typically Carboniferous genus occurs sparingly in the Neodevonian, but no species have been reported from Mesodevonian horizons. That it was present, however, in both the Corniferous and Hamilton periods is proved by at least two specimens which have come under the writer's observation. One of these is a large tooth from the Corniferous limestone of Columbus, Ohio, now preserved in the American Museum of

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[1] Rep. Ohio Geol. Survey, Vol. VII, 1893, p. 611.

[2] Bull. Mus. Comp. Zoöl., Vol. XXXI, 1897, p. 24.

[3] Amer. Geol., Vol. X, 1892, p. 1.

[4] *Ibid.*, Vol. XII, 1893, p. 278.

Natural History in New York (Cat. No. 4257). Although very similar to *C. striatus* Ag., it probably belongs to a distinct species.

C. monroei, sp. nov. (Fig. 3).—The type of this species is a small, imperfectly preserved tooth found by Mr. C. E. Monroe in the Hamilton of Milwaukee. The drawing reproduced herewith is made up from both halves of the counterpart containing the specimen. Traces of striae appear in places, but are nearly obliterated by decay of the enamel and dentine, and portions of the crown and base are broken away. The crown is robust, being very thick at the base, and the external denticles are proportionately stout. Three cusps of small size intervene on each side between the principal cone and external denticles. The total height may be estimated at about 1.3^{cm}, and the width of base at 2.5^{cm}.

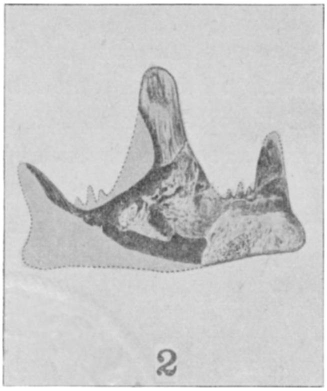

FIG. 2. *Cladodus monroei* sp. nov. Hamilton limestone; Milwaukee, Wisconsin. $\times \frac{2}{1}$.

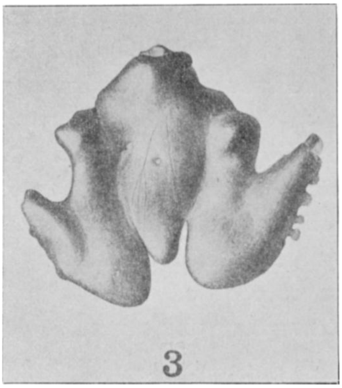

FIG. 3. Supposed cone-scale from Kinderhook fish-bed at Burlington, Iowa. $\times \frac{2}{1}$.

Other Corniferous forms occurring in the same horizon at Milwaukee are teeth and plates of *Onychodus*, spines of *Machaeracanthus*, and Chimaeroid remains. *Macropetalichthys* and *Asterosteus*, however (which on account of their cranial osteology and lack of dentition we must now exclude from *Arthrodira* and place with the Ostracoderms as degenerate Elasmobranch offshoots), are conspicuously absent.

GENUS *DIPTERUS*, SEDGWICK AND MURCHISON

There are two distributional centers for this genus in America, between which there was apparently no communication. In the eastern province, which includes the Chemung-Catskill of New York and Pennsylvania, it is associated with forms common to the Upper Devonian of Canada and Europe. In the western province (Iowa and Illinois to Manitoba) it ranges from the base of the Hamilton to near the top of the Devonian and is accompanied by *Ptyctodus* and a number of Dipnoan forms peculiar to this region.[1] Here are found no traces of Crossopterygians or Ostracoderms; in fact the western Neodevonian fish-fuana is entirely distinct from the eastern, and represents a different migratory movement.

The Chemung proper contains but two well-recognized species of Dipterus, *D. flabelliformis* and *D. nelsoni*, the latter including Newberry's so-called *D. levis* (founded on worn specimens), and possibly *D. quadratus* and *D. minutus*. From the Catskill of Pennsylvania four species are known: *D. sherwoodi*, *D. fleischeri*, *D. angustus* and *D. contraversus* (= *D. radiatus* N.). Several of these species are founded on imperfect material, and the original descriptions require emendation. To this list may now be added four new species from the Middle and Upper Devonian of Iowa, the types of which are preserved in the Museum of Comparative Zoölogy at Cambridge, Massachusetts.

1. *D. uddeni*, sp. nov. (Fig. 5).—This species is established on a unique mandibular dental plate from the base of the Cedar Valley limestone (Middle Devonian) near New Buffalo, Iowa. It has a total length of 36^{mm}, is moderately convex, and remarkable for the paucity of its denticulated ridges. These are only four in number, and radiate in gently curved lines from the posterior angle, which is worn smooth by use. The anterior row of denticles and inner moiety of the remaining rows are also considerably worn; but in the outer moiety of these rows the denticles are acutely conical, of large size and well separated.

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[1] Ann. Rep. Iowa Geol. Surv., Vol. VII (1896), Pl. IV; *ibid*, Vol. IX (1898), p. 302; JOUR. GEOL., Vol. VII (1899), p. 77.

There is a progressive diminution in size of all denticles proceeding posteriorly. The coronal surface is finely punctate.

This beautiful dental plate is the oldest of all *Dipterus* remains that have been found in this country. It was discovered by Professor J. A. Udden of Augustana College, Rock Island, in whose honor the specific title is dedicated. A note of its geological occurrence was published in the August number of this JOURNAL (p. 494) for last year.

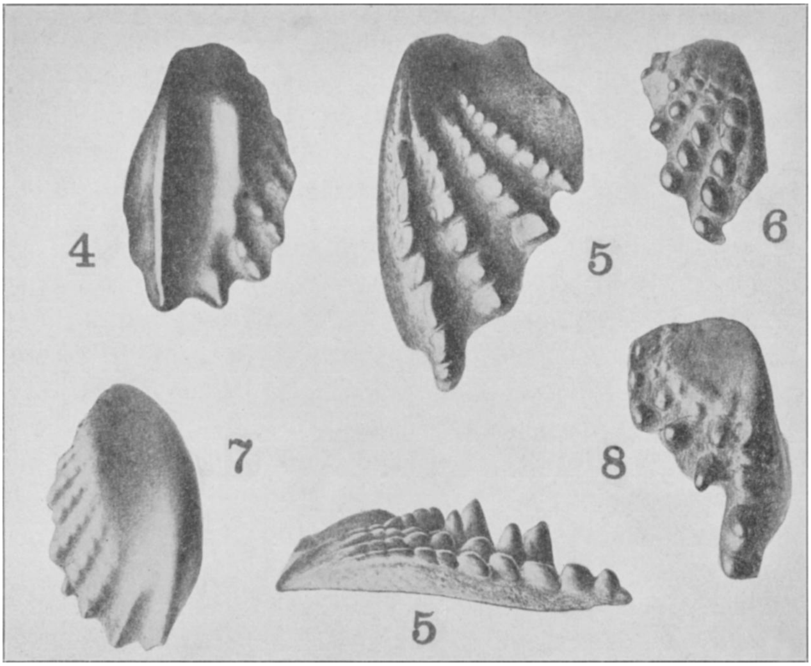

FIG. 4. *Dipterus costatus* sp. nov. Upper Devonian ; Johnson county, Iowa.

FIGS. 5, 5^{1}. *Dipterus uddeni* sp. nov. Cedar Valley limestone ; New Buffalo, Iowa.

FIGS. 6, 8. *Dipterus mordax* sp. nov. Upper Devonian ; Johnson county, Iowa.

FIG. 7. *Dipterus calvini* sp. nov. Cedar Valley limestone ; Fairport, Iowa.

2. *D. calvini*, sp. nov. (Fig. 7).—Like the last, this species is founded on a unique dental plate (right mandibular) from the Cedar Valley limestone of Iowa. It comes from a higher level,

however, having been found by Professor Udden in the so-called "Euomphalus bed" at Fairport, Muscatine county, which lies about eight feet below the summit of the Cedar Valley limestone, or Hamilton of Worthen and others.

The plate is elliptical in outline, and moderately convex in an antero-posterior direction. Eight tuberculated ridges extend from the outer margin to about the center of the plate, the two anterior ones being the largest and elevated into a slight fold. Coronal surface considerably worn, and external margin partially broken. Tubercles conical and well separated, except those of the two anterior ridges, which are coalesced and worn on their summits. Total length of plate 3^{cm}. Named in honor of Professor Samuel Calvin, State Geologist of Iowa.

3. *D. costatus*, sp. nov. (Fig. 4).—This plate agrees in size and general outline with *D. calvini*, but it has fewer and more widely separated coronal ridges which disappear before reaching the center of the plate. The distinguishing feature of this species consists in the elevated sharp ridge extending along the entire length of the inner margin, and separated from the remaining tuberculated ridges by a broad longitudinal furrow. This ridge appears to be of compound origin, or made up of three coalesced costae, of which the third counting from the inner margin is the largest. The two innermost costae are so faint as to be almost imperceptible on the steep face of the main ridge. The summit of the latter is sharp, and shows no evidence of being made up of tubercles. The tubercles of the five marginal ridges are also worn nearly smooth and more or less coalesced. But for the convexity (in a longitudinal direction) of the coronal surface this might be taken for an upper dental plate. Several examples of this form have been obtained from the State Quarry fish-bed near North Liberty, in Johnson county, Iowa.

4. *D. mordax*, sp. nov. (Figs. 6, 8).—Dental plate attaining a length of over 3^{cm}, coronal surface gently convex, with six rows of very large, well separated conical or rounded tubercles which extend from the outer margin for a variable distance

toward the posterior angle; the two posterior rows often rudimentary. Some of the tubercles, when worn by use, become elongated in the direction of the rows to which they belong, and others in an oblique direction. This species is readily distinguished from all others previously described by the relative coarseness of its tuberculation. It is represented by a number of examples from the State Quarry beds of Johnson county, Iowa.

NOTICE OF PROBLEMATICAL ORGANISMS

Some thirty years ago Mr. Orestes St. John, when assistant in the Museum of Comparative Zoölogy, collected a number of Selachian teeth and spines and some large Dinichthyid plates from a "fish-bed" near Burlington, Iowa, supposed to be near the dividing line between Upper Devonian and typical Kinderhook. Small spines of *Stethacanthus*, *Erismacanthus*, and *Homacanthus* are rather abundant at this locality, also dermal tubercles of sharks. From the upper part of the formation Mr. St. John obtained the carapace of a Schizopod crustacean, and also some vegetable remains, such as branches of a Lepidodendron and woody fibers. In addition he found a number of peculiar fossils of which the one shown in Fig. 2 is a fair example, and within the past year other specimens of the same sort have been collected by Professor Udden in the Kinderhook near Burlington.

An examination of the latter forms by Professor Arthur Hollick of Columbia College leads him to the opinion that they are cone-scales of some conifer probably allied to *Araucaria*. A figure is given herewith for the benefit of those interested in the study of Mississippian faunas.

EXPLANATION OF FIGURES

FIG. 1. *Dinichthys pustulosus* E. Hamilton limestone; Milwaukee, Wisconsin. Left ramus of mandible. $\times \frac{2}{5}$.

FIG. 2. *Cladodus monroei* sp. nov. Hamilton limestone; Milwaukee, Wisconsin. $\times \frac{2}{1}$.

FIG. 3. Supposed cone-scale from Kinderhook fish-bed at Burlington, Iowa. $\times \frac{2}{1}$.

FIG. 4. *Dipterus costatus* sp. nov. Upper Devonian; Johnson county, Iowa. Left lower dental plate.

FIGS. 5, 5[1]. *Dipterus uddeni* sp. nov. Cedar Valley limestone; New Buffalo, Iowa. Left lower dental plate, oval surface and profile.

FIG. 6, 8. *Dipterus mordax* sp. nov. Upper Devonian; Johnson county, Iowa. Somewhat worn examples of right lower dental plates.

FIG. 7. *Dipterus calvini* sp. nov. Cedar Valley limestone; Fairport, Iowa. Right lower dental plate.

[Figs. 4–8 reduced slightly less than natural size.]

C. R. EASTMAN.